REMARKS

Claim 8 was rejected under 35 U.S.C. § 112, second paragraph. The Examiner considered the language "wherein said platinum-metal-based electroless plated layer is an electroless Pd-plated layer" to be unclear.

Applicants respond as follows.

Claim 8 depends from claim 6 which recites that a platinum-metal-based electroless plated layer is disposed as a barrier metal layer between the Cu-plated layer and the Au-plated layer. As described at page 8, lines 12-17 of the specification, the platinum-metal-based electroless plated layer refers to an electroless plated layer containing a platinum-group metal, namely, any one of Ru, Rh, Pd, Os, Ir and Pt as its chief component. Thus, claim 8 which recites that the platinum-metal-based electroless plated layer is an electroless Pd-layer further limits claim 6 and its meaning is clear.

Withdrawal of the foregoing rejection is requested.

Claims 1-7, 9 and 10 were rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent 6,815,126 to Fey et al. in view of Chow et al. ("Surface Properties and Solderability Behaviour of Nickel-Phosphorous and Nickel-Boron Deposited by Electroless Plating", Surface and Interface Analysis, Vol. 31, (2001), pp. 321-327.

Fey et al. was cited as disclosing a wiring board 10 including a plurality of metal terminal pads (circuit traces) 40 disposed on a main surface of the wiring board, the metal terminal pads including a Cu-plated layer 28 disposed on the side of the first main surface, an Au-plated layer 64 disposed in an outermost surface layer portion of the metal terminal pad, and an electroless

Ni-plated layer arranged as a barrier metal layer between the Cu-plated layer and the Au-plated layer.

The Examiner relies on Chow et al. as disclosing the use of commercially available Ronamax AL plating chemical to form electroless Ni deposits, the plating chemical containing 2-4 wt % P, for improving adhesion to Cu films.

The reason for rejection was that it would have been obvious to use the Chow et al. electroless nickel having a low P content as electroless Ni layer 62 in Fey et al. to provide for increased film adhesion and solderability.

With respect to claim 3, the Examiner cited Niposit 468 containing 0.25 wt. % B for use as the electroless Ni layer.

As to claim 4, the Examiner cites to Fig. 9 of Fey et al. showing Ni layer 62 in direct contact with Au-plated layer 64. As to claim 5, the Examiner considered that setting the thickness of the Ni-plated and Au-plated layers is subject to routine experimentation and optimization to achieve the desired electrical resistances.

Relative to claims 6 and 7, the Examiner cited Fig. 9 of Fey et al. as disclosing platinum-metal-based electroless plated layer 62 disposed as a barrier layer between the Cu-plated layer and the Au-plated layer (citing column 6, lines 11-15 and column 8, lines 30-37).[1] The Examiner also relies on the same passages with respect to claim 9. As to claim 10, the Examiner

[1] The cited passages refer to the more noble metal layer 60, shown in Figs. 6 to 8, which may comprise two layers including a first layer of electrolytic nickel 62 and a second layer of electrolytic gold 64. See column 8, lines 35-39. The more noble metal layer 60 is disposed over commoning layer 46.

considers that the claimed thickness is subject to routine experimentation and optimization to achieve the desired electrical resistances.

Applicants traverse, and respectfully request the Examiner to reconsider for the following reasons.

The Examiner cited Fey et al., and specifically Fig. 9, as disclosing electroless Ni-plated layer 62 disposed as a barrier layer between the Cu-plated layer and Au-plated layer. However, that is not correct. Ni-plated layer 62 is an electrolytic nickel 62 (column 8, lines 37-38). As described at column 9, lines 8-12, the nickel can be plated from a conventional Watts bath or from a nickel sulfamate bath, both of which are electrolytic baths. See also the Abstract at line 9, which describes the thin nickel layer as being "electrodedeposited" over the exposed conductive layer. That is, Ni-plated layer 62 is an electrolytic nickel. The passage at column 9, lines 35-41 cited by the Examiner simply refers to "the nickel layer 62". There is no mention of an electroless Ni-plated layer 62 as suggested by the Examiner.

Furthermore, the Examiner considered Fey et al. as disclosing that the Ni-plated layer 62 is disposed as a barrier layer, again citing the same passage. However, that is not what Fey et al. says. Rather, Fey et al. provides the electrolytic Ni layer (together with the gold layer) to form a conformal layer that covers the top and extends down the sides of the trace (column 9, lines 41-43).

Chow et al. surely discloses EN-LP (electroless nickel-low phosphorous) plating which is said to improve solderability (as compared to electroless nickel-high phosphorous plating).

Because Fey et al. employs electroplated Ni layer 62 (together with the gold layer) to form a conformal layer, whereas Chow et al. simply discloses that EN-LP has better solderability than EN-HP (with no mention of conformal properties), there is nothing in the cited prior art which would lead one of ordinary skill to substitute the electrolytic Ni of Fey et al. with the electroless nickel-low phosphorous plating of Chow et al.

Applicants rely on the response above with respect to the rejection of claim 3.

With respect to claim 4, Fig. 9 of Fey et al. surely shows electrolytic nickel layer 62 in direct contact with electrolytic Au layer 64. However, the Ni layer is not an electroless layer as suggested by the Examiner.

Applicants furthermore urge separate patentability of claims 5 and 10 with respect to the thickness of the Ni-plated layer, the Au-plated layer and the platinum-metal-based electroless plated layer. These preferred embodiments of the invention, described at page 24, lines 13-21; at page 26, lines 7-18 and at page 27, lines 1-12 of the specification represent certain thickness ranges that the present inventors have found to best illustrate the effects of the invention. The Examiner simply dismissed the thickness ranges as claimed in claims 5 and 10 to be "subject to routine experimentation", although acknowledging that Fey et al do not disclose or even address the claimed thickness parameters. Therefore, Applicants dispute that the specifically claimed thickness ranges set for the specific structures of the present invention are in any way obvious over Fey et al.

Furthermore, relative to claims 5 and 10, the Examiner recognizes that Fey et al. does not disclose the thickness of layers 62 and 64, but considers that such is subject to routine experimentation and optimization to achieve the desired electrical resistances.

Applicants dispute the Examiner's reasoning.

The nickel/gold layer is a conforming layer that extends down the side of the copper traces, and has nothing to do with resistance of copper foil 20 or connecting to the circuit traces 40. See Abstract.

With respect to claims 6, 7 and 10, the Examiner refers to Fig. 9 as showing a platinum-metal-based electroless plated layer disposed as a barrier between the Cu-plated layer and the Au-plated layer. This is the "more noble metal" layer 60. In Fig. 9, the "more noble metal" layer 60 is shown as two distinct layers, including a first electrolytic nickel layer 62 and a second electrolytic gold layer 64. However, as described at column 6, lines 11-15, in addition to nickel electrodeposit on the copper commoning layer 46 and gold electrodeposit on the nickel, the "more noble metal" layer 60 can comprise other metals, such as platinum, cobalt, silver, tin and its alloys. The point here is that Fey et al. discloses that layer 60 must be "more noble" than commoning layer 46 (typically flash copper), and which may comprise any of nickel, platinum, cobalt, silver, tin and its alloys. There is no specific teaching here of a platinum-metal-based electroless plated layer having any one of Ru, Rh, Pd, Os, Ir and Pt as its chief component.

For the above reasons, it is respectfully submitted that claims 1-7, 9 and 10 are patentable over Fey et al in view of Chow et al, and withdrawal of the foregoing rejection under 35 U.S.C. § 103(a) is respectfully requested.

Claims 11-16 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Fey et al. in view of Chow et al., further in view of U.S. Patent 5,235,139 to Bengston et al.

Fey et al. (Fig. 6) was cited as disclosing noble metal layer 60, which may comprise two layers, formed on metal terminal pads 40, followed by an electroless Au layer (citing column 8, lines 35-37 and column 9, line 41). The Examiner relied on Bengston et al. as disclosing the formation of a two-layer structure where an electroless Ni-B layer 24 is formed, followed by an electroless Ni-P layer 26 where the Ni-B layer serves as a P-barrier electroless metal plated layer.

The reason for rejection was that it would have been obvious to rearrange (i.e., reverse), the electroless Ni plated layer sequence in Bengston et al., and to introduce the same into the structure of Fey et al. so as to reduce interdiffusion and to produce an efficient and reliable bond pad.

Applicants respectfully traverse for the following reasons.

The rejected claims require a specific combination of a P-barrier electroless metal plated layer (Ni-B based electroless Ni-plated layer) and a Ni-P based electroless Ni-plated layer, where the P-barrier electroless metal plated layer is disposed between the Ni-P-based electroless Ni-plated layer and the Au-plated layer. This specific combination is not disclosed by any of the cited prior art as shown below.

Fig. 6 of Fey et al. shows "more noble metal" layer 60 which may comprise two distinct layers on commoning layer 46. When copper is used as the commoning layer, Fey et al. teaches that any of more noble metals such as zinc, cadmium, chromium, nickel, cobalt, gold, silver, palladium, platinum, ruthenium and alloys with each other and with tin and lead may be used

(column 8, lines 30-35). The more noble metal is electrodeposited as a conforming layer over the exposed commoning layer, and can comprise a first electrodeposit of nickel followed by a gold layer applied over the nickel in precise registry therewith (column 4, lines 59-63).

Bengston et al. discloses a metallized through-hole (column 5, lines 39-40) which may include a Ni-B layer 24 and Ni-P coating 26.

The claimed P-barrier electroless metal plated layer may be a Ni-B-based electroless Ni-plated layer (page 10, lines 11-12 of the specification). However, the particular order of the P-barrier electroless metal plated layer and Ni-P-based electroless Ni-plated layer is critical, and the Examiner would simply rearrange the sequence taught by Bengston et al. to reduce interdiffusion. However, Bengston et al. arranges his layers in a specific sequence and in special order for a specific purpose. This layer sequence cannot be rearranged to just satisfy hindsight reconstruction of Applicants' invention. As taught by the present Applicants bridging pages 9-10 of the specification, because the P-barrier electroless metal plated layer is disposed between Ni-P-based electroless Ni-plated layer and the Au-plated layer, a P-thickened layer possibly formed is isolated from the Au-plated layer by the P-barrier electroless metal plated layer. Consequently, solder wettability to the metal terminal pads can be improved on a large scale. None of this is taught or suggested by any of the cited prior art.

For the above reasons, it is respectfully submitted that claims 11-16 are patentable over Fey et al in view of Chow et al, further in view of Bengston et al, and withdrawal of the foregoing rejection under 35 U.S.C. § 103(a) is respectfully requested.

Claims 17-21 were rejected under U.S.C. § 103(a) as being unpatentable over Fey et al. in view of Bengston et al. The Examiner relies on Fey et al. and Bengston et al. as discussed above, except that the ordering of the electroless Ni layers is not reversed. The Examiner further considered that it would have been within the level of ordinary skill to form the Ni-P-based electroless metal plated layer thinner than the Ni-B-based electroless Ni-plated layer "to form a contact of reduced resistance".

Applicants respectfully traverse for the following reasons.

As discussed at page 12, lines 10-19 of the specification, because the Ni-P-based electroless metal plated layer is formed to be thinner than the Ni-B-based electroless Ni-plated layer, the degree of formation of a P-thickened layer is so low that the fear of failure in solder wettability, failure in adhesion, or the like, is reduced.

However, Bengston et al. teaches the opposite. Namely, Bengston et al. teaches that Ni-B strike layer 24 is a thin strike layer on the order of about 0.1 to 1.0 μm in thickness, which is then followed by a Ni-P or Co-P coating 26 to full desired thickness (column 6, lines 49-55). In the Example at column 8, Bengston et al. teaches forming a Ni-B strike coating having a thickness of about 4 microinches (i.e., 0.1 μm), followed by a Ni-P coating 0.3 mills thick (300 microinches or about 7.5 μm). That is, whereas claims 17 and 18 require a Ni-P-based electroless metal plated layer thinner than the Ni-B-based electroless Ni-plated layer, Bengston et al. teaches just the opposite.

Withdrawal is respectfully requested.

Claims 22-24 and 26-28 were rejected under U.S.C. § 103(a) as being unpatentable over Fey et al. in view of Chow et al., further in view of Lee, "Lead-Free Chip Scale Soldering of Packages", Chip Scale Review (March-April, 2000), pp. 1-6.

Acknowledging that Fey et al. does not disclose solder balls, the Examiner considered that the connection of wiring boards to other elements through solder balls at pad areas is well established in the art. Lee was cited as disclosing SnAg alloy solder having a liquidus temperature of not lower than 200°C. The reason for rejection was that it would have been obvious to combine Lee and Fey et al. to obtain solder connection areas of improved strength and compatibility with conductive pads.

Applicants respectfully traverse for the following reasons.

Fey et al. does not disclose metal terminal pads, and therefore also does not disclose solder balls. Namely, Fey et al. discloses a printed wiring board with conformally plated circuit traces and as the Examiner acknowledged, does not show solder balls.

From a different aspect, the particular structure of the metal terminal pads of present claim 1 avoid formation of a P-rich layer without consequent reduction in bonding strength. Thus, a higher melting point and more environmentally friendly solder not containing Pb can be used. This is because the margin for forming a reliable solder bonding structure is expanded. As discussed at page 17, lines 14-24 of the specification, this effect is conspicuous particularly when the high temperature solder ball is bonded directly to a metal terminal pad.

Namely, it is the specific combination of the metal terminal pad of claim 1, having a specifically defined structure and composition, which allows for use of a high melting solder (not

containing Pb), which combination is unobvious over the applied prior art. Lee surely teaches lead-free solders. However, it is the specific structure and composition of the metal terminal pad which allows for its use in providing reliable bonding structures.

Applicants dispute the Examiner's comment that the use of a high melting solder provides connection areas of improved strength. Rather, just the opposite is true. Namely, the use of a high melting solder does not provide connection areas of improved strength in general. This is because Sn components in the solder contribute to the connection, and the amount of Sn components is small in a high melting solder.

Also, claims 22-24 and 26-28 are patentable for the same reasons that claim 1 is patentable over the cited prior art.

Withdrawal of the foregoing rejection under 35 U.S.C. § 103(a) is respectfully requested.

Claims 25 and 29 were rejected under U.S.C. § 103(a) as being unpatentable over Fey et al. in view of Chow et al., further in view of Hwang et al., "Effects of Pb Contamination on the Material Properties of Sn/Ag/Cu Solder", Chip Scale Review (January-February 2001), pp. 1-5. The Examiner cited Hwang et al. as disclosing Sn solder alloys having a Pb content of not higher than 5 % by mass.

Applicants respectfully traverse for the following reasons.

It is the combination of the metal terminal pad of claim 1, having a specific structure and composition, which allows for use of a high melting solder while still providing a reliable bond. Hwang et al. may teach a low Pb solder, but Hwang et al. and none of the cited prior art teaches

how to use such solder together with a wiring board including metal terminal pads, as claimed, while still providing a reliable bond.

Withdrawal of the foregoing rejection is respectfully requested.

Claims 30-32 were rejected under U.S.C. § 103(a) as being unpatentable over Fey et al. in view of Chow et al., and further in view of Lee.

Applicants rely on the response above with respect to the rejection of claims 22-24 and 26-28 over Fey et al in view of Chow et al and further in view of Lee.

Claims 34-36 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Fey et al in view of Lee.

Applicants rely on the response above with respect to the rejection of claim 22, further in reference to the wiring board of claim 17.

Withdrawal of all rejections and allowance of claims 1-37 is earnestly solicited.

In the event that the Examiner believes that it may be helpful to advance the prosecution of this application, the Examiner is invited to contact the undersigned at the local Washington, D.C. telephone number indicated below.

The USPTO is directed and authorized to charge all required fees, except for the Issue Fee and the Publication Fee, to Deposit Account No. 19-4880. Please also credit any overpayments to said Deposit Account.

Respectfully submitted,

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